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The usefulness of the reach angle concept for hazard zoning using statistical approach

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Since Heim (1932) the reach angle or Farböschung or the shadow angle has been widely studied to estimate runout distance of landslides and snow avalanches. The distance used to determine the reach angle is based either on the maximum of runout distance or on a threshold distance. This discrepancy between deterministic and statistical approaches has to be explained.
We inspected the uncertainty on the parameters of the simple model of the energy line. The relevant uncertainty comes essentially from the friction parameters along the travel of the moving mass. As a consequence the friction coefficient can be assumed as a random variable along the landslide path. Passing at the limit the friction coefficient can be assumed as a sum of random variables. Owing to the central limit theorem the friction coefficient must follow a normal distribution.
This hypothesis of normal distribution of friction angle is equivalent to the reach angles if the assumed variability is only of a few degrees. The results of this theory can be verified on several gravitational movements' data sets such as rock falls, shallow landslides, snow avalanches, etc. This permits also to unify all the different approaches taking into account the differences between energy line and Farböschung. The Farböschung appears as a limiting case of energy line slope.